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Smart Restaurant Management System Using QR Code

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Abstract: *The restaurant business is depending more and more on digital technologies to boost customer satisfaction and operational effectiveness. Longer wait times, incorrect orders, and ineffective service during busy hours are common outcomes of traditional restaurant ordering systems, which mostly rely on manual interaction between patrons and waitstaff. Printed menus also need to be updated frequently and physically handled, which is inconvenient for both patrons and restaurant management. Many small and medium-sized restaurants still use traditional ordering techniques, which restrict service scalability and operational efficiency, despite the availability of contemporary technologies.*

The Smart Restaurant Management System utilizing QR Code, a web-based platform intended to streamline restaurant ordering through contactless digital interaction, is presented in this paper. Customers can use their cellphones to scan QR codes on restaurant tables to access a digital menu interface. Without the help of restaurant employees, patrons can explore food products, choose dishes, add them to a cart, and confirm orders straight from mobile devices. This method minimizes communication issues between clients and service staff while drastically cutting down on order processing time.

Modern web technologies, such as Next.js for frontend development, Node.js API routes for server-side processing, and MongoDB for database administration, are used to construct the backend architecture. The platform guarantees effective communication between system components and safe data processing. Through RESTful API endpoints, the application handles crucial functions like order processing, table identification, cart management, and menu retrieval. The system updates the restaurant's order management interface and enters the order details in the database after a customer confirms an order.

The findings show that QR-based ordering systems provide contemporary restaurants looking to implement contactless and automated service models an efficient and scalable alternative. Future improvements could include AI-based recommendation engines for customized menu ideas, kitchen display systems, and interaction with online payment systems.

Index Terms: *QR Code Ordering System, Restaurant Automation, Digital Menu, Web Application Architecture, Contactless Ordering.*

I. INTRODUCTION

As the food service sector continues to grow, managing customer orders effectively in contemporary restaurants has grown more crucial. During peak hours, restaurants frequently have a lot of patrons, which makes it difficult for employees to process orders accurately and promptly. The significance of incorporating digital technologies to increase service efficiency and decrease manual procedures in catering contexts is highlighted by recent developments in restaurant automation systems [1]. Waiters deliver printed menus, receive spoken orders, and relay those requests to the kitchen staff in traditional restaurant operations, which usually rely on manual procedures. Although this method has been in use for a long time, it frequently results in order misunderstanding, delays, and ineffective service management.

A. Background and Motivation

It is evident from analyzing present restaurant operations that a significant number of service inefficiencies result from the overwhelming reliance on manual processes. Web-based restaurant management systems have been extensively researched as efficient ways to expedite order processing and menu management [2]. Customers in a typical restaurant setting have to wait for a waiter to come to their table, provide menus, take orders, and deliver them to the kitchen. Because employees are frequently in charge of several tables at once, this process can become laborious and prone to mistakes during peak hours.

Keeping menus current is another issue that eateries deal with. Every time new dishes are added or pricing change, printed menus need to be updated. Customers can explore available food products, choose dishes, and place orders immediately through a web-based interface with this method, which does away with the necessity for printed menus.

B. Problem Statement

Even with the availability of contemporary digital technologies, many restaurants continue to use antiquated ordering methods that are ineffective and prone to human mistake. Manual order-taking procedures make it more likely that customer requests will be recorded incorrectly, which could result in inaccurate orders and unhappy customers. Additionally, restaurant employees might find it difficult to effectively oversee several tables at busy periods, which would lengthen patrons' wait times. Additionally, contactless ordering systems that use QR codes to enable consumers to access digital menus via smartphones without requiring physical touch have been investigated by researchers [3].

Furthermore, some restaurant management platforms don't offer a fully integrated system for order handling and database storage, instead concentrating just on menu presentation. Restaurants are unable to effectively handle incoming orders or monitor service operations without adequate backend integration. Consequently, A lightweight, easily accessible, and completely integrated digital system that enables patrons to place orders fast and gives restaurants effective order management capabilities is obviously needed.

C. Objectives

The main goal of this study is to create and implement a smart restaurant management system that uses QR code technology to streamline the ordering process. The specific objectives of this project are:

- 1) To create a web application that enables patrons to scan QR codes on restaurant tables to obtain a digital menu.
- 2) To put in place a scalable backend system that can effectively handle table information, customer orders, and menu data.
- 3) To create an interactive user interface that makes it simple for customers to browse menu items, add goods to a cart, and confirm orders.
- 4) To incorporate a dependable database system that facilitates effective restaurant management operations and stores order information.

D. Contributions and Paper Organization

In order to increase customer convenience and service effectiveness, this paper offers a thorough framework for putting into practice a restaurant management system based on QR codes. Numerous studies show that restaurant automation frameworks can greatly shorten wait times and enhance customer-service staff communication [4]. The creation of a responsive digital ordering interface, the incorporation of backend services for order processing, and the construction of a database structure that facilitates effective restaurant operations management are the primary contributions.

This is how the rest of the paper is structured. Research on QR code-based ordering technologies and digital restaurant systems is reviewed in Section II. The suggested system design and techniques are explained in Section III. The evaluation and performance outcomes of the established system are shown in Section IV. The system's shortcomings and important design observations are covered in Section V. Section VI concludes by summarizing the findings and outlining potential future improvements.

II. LITERATURE SURVEY

In an effort to increase customer satisfaction and operational efficiency, businesses have recently looked at integrating digital technologies into restaurant services. Researchers have looked at a number of methods for digitizing restaurant operations, such as online ordering platforms, mobile applications, and QR code-based menu systems, as the hospitality sector increasingly uses automated technology. Restaurants can also dynamically change menu items and prices without the need for printed materials thanks to digital menu technologies [5]. The necessity for scalable digital solutions that may streamline the ordering process while preserving efficiency and dependability is highlighted by a review of the literature, which also identifies a number of significant issues with traditional restaurant administration.

A. Traditional Restaurant Management Systems and Operational Limitations

Order taking, menu distribution, and customer-kitchen staff contact are all done manually in traditional restaurant management systems. In a normal restaurant, waiters provide patrons printed menus, take verbal or written orders, and deliver them to the kitchen for processing.

Despite the decades-long widespread adoption of this strategy, scholars have repeatedly highlighted its operational inefficiencies. The increased likelihood of communication errors between clients and service personnel is one of the main drawbacks of manual ordering methods. Restaurant staff frequently have to oversee several tables at once during busy times, which raises the possibility that they will record orders inaccurately or overlook patron demands. Additionally, because employees must constantly move between tables and the kitchen to exchange information, manual order management greatly slows down the service process. Additionally, order recording errors are reduced and overall operational efficiency is enhanced by web-based ordering applications [6]. The challenge of maintaining printed menus is another significant issue that has been brought to light in earlier research. New menus must be produced and disseminated whenever eateries change their menu items or prices, which raises operating costs and causes changes to be delayed.

B. QR Code-Based Digital Menu Systems

As smartphones and internet connectivity have become more common, QR codes have become a useful technology for frictionless access to digital data. QR codes can be put on tables or menus in restaurants so that patrons can rapidly access digital menus by scanning them with the cameras on their smartphones.

QR code-based ordering systems can drastically cut down on customer wait times and boost overall restaurant service effectiveness, according to several studies. By enabling patrons to independently make orders using their mobile devices, QR code-enabled restaurant systems have been demonstrated to improve service speed [7]. Customers can freely peruse menu items and place orders using their mobile devices rather than waiting for a waiter to provide a menu or take orders. This avoids communication problems during the ordering process and lessens the workload of restaurant employees.

However, rather of offering a fully integrated ordering mechanism, current QR code menu implementations frequently concentrate solely on showing menu information. Some systems don't provide interactive ordering; instead, they just send users to static menu pages.

C. Web-Based Restaurant Ordering Platforms

The creation of full-stack restaurant ordering platforms that combine digital menus, order processing, and database administration has been made possible by recent developments in web technology.

Web-based restaurant management systems offer a number of benefits over conventional mobile applications, according to Relying researchers. Real-time menu browsing and effective order management are features of contemporary restaurant systems created with web technology [8].

Despite these benefits, a lot of the restaurant management systems that are now in use are made mainly for big businesses and need complicated infrastructure. Because of the high development costs and technological complexity of such systems, small and medium-sized restaurants frequently struggle to deploy them. As a result, there is still a great need for scalable and lightweight restaurant management systems that are simple to use and don't require a lot of technical expertise.

III. PROPOSED METHODOLOGY

Customers will be able to view digital menus and place food orders immediately through their smartphones in a smooth and effective environment thanks to the planned Smart Restaurant Management System. The suggested platform offers a contactless and automated ordering workflow in contrast to conventional restaurant ordering systems that mostly rely on human interaction between patrons and service personnel.

A. System Architecture (Web Application Architecture and Database Integration)

A contemporary three-tier web architecture that divides the user interface from the backend processing and data storage layers is used in the construction of the suggested system. Improved performance, scalability, and maintainability are guaranteed by this architectural approach (Fig.1).

- 1) Presentation Layer: manages the user interface where clients may examine the digital menu, choose food products, scan QR codes, and place orders via the web application.
- 2) Application Layer: The backend processes queries, maintains menu data, supervises cart operations, and completes customer orders. It is powered by Node.js and Next.js API routes.
- 3) Data Layer: effectively stores and manages menu items, orders, tables, and cart information using MongoDB and Mongoose ODM (Fig.2).

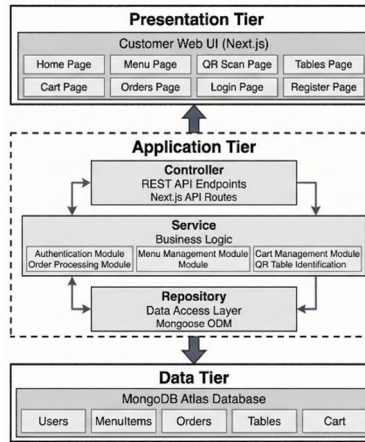


Fig.1. System architecture of the proposed QR-based restaurant ordering system.

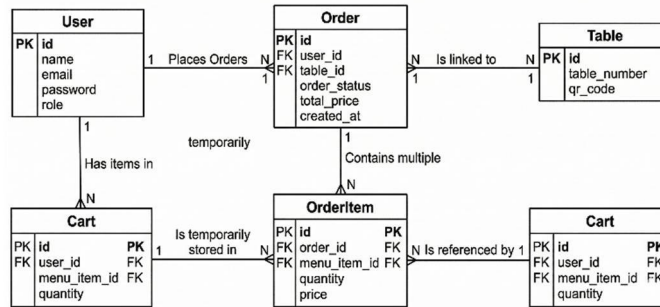


Fig.2. Entity Relationship Diagram of the Smart Restaurant Management System database.

B. Functional Modules (Menu Management, Order Processing, and Table Identification)

The suggested system is broken up into multiple functional modules that manage various facets of restaurant operations in order to guarantee a seamless user experience.

Customers scan the QR code on the restaurant table in the QR Code Identification Module to start the process (Fig.3). Additionally, these computerized technologies lessen the workload of restaurant staff while increasing consumer convenience [9]. Customers can use the Menu Management Module to peruse food items once the menu interface has been opened. This module pulls menu data from the database and arranges it according to categories like vegetarian and non-vegetarian options, drinks, and appetisers.

The basket Management Module allows customers to choose products and add them to their basket. Before the order is confirmed, certain things are momentarily stored in this module.

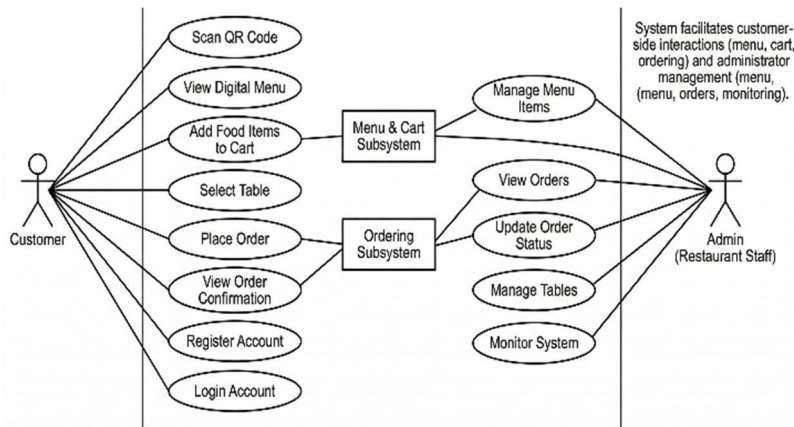


Fig.3. Use case diagram illustrating customer interactions in the Smart Restaurant Management System using QR Code.

C. Digital Menu Interface and Interactive Ordering System

The interactive digital menu interface is a crucial component of the suggested platform. Waiters must manually enter customer orders and present menus in traditional restaurant systems, which can slow down service. Scalable order management and data storage for eateries with high customer volumes are further supported by cloud-based restaurant automation technologies [10]. There is an option to add each menu item to the cart. Consumers can examine their choices, change quantities, and delete goods if needed. Customers can handle their orders on their own without waiting for human support thanks to this interactive interface.

D. Order Processing Workflow and Backend Data Handling

Customer requests are processed effectively and properly in the database thanks to the backend order processing system. The frontend sends an API request with order details, including selected goods, quantities, and table number, to the backend server when a customer confirms an order.

The order is entered into the MongoDB database by the backend program, which also verifies the request. Relevant data, such as menu items, order status, and table identity, are recorded with each order.

The system follows a structured workflow consisting of the following steps:

- 1) Customer scans the QR code placed on the table.
- 2) The digital menu page opens on the customer’s smartphone.
- 3) The customer browses menu items and selects desired dishes.
- 4) Selected items are added to the cart.
- 5) The customer reviews the cart and confirms the order.
- 6) The backend server processes the order request.
- 7) Order details are stored in the database.
- 8) The restaurant receives the order for preparation.

E. QR Code Integration and System Workflow

The contactless ordering process is made possible in large part by QR code technology. A distinct QR code that connects to the restaurant's online application is given to each table. The QR code locates the table and takes the user to the relevant menu page when scanned (Fig.4). With this method, printed menus are no longer necessary, and restaurants can use the database to dynamically update menu items. Customers can communicate with restaurant services directly through web-based digital menu systems without having to install mobile applications [11]. The technology is appropriate for eateries that want to raise hygienic standards while boosting service effectiveness since the usage of QR codes satisfies contemporary contactless service criteria.

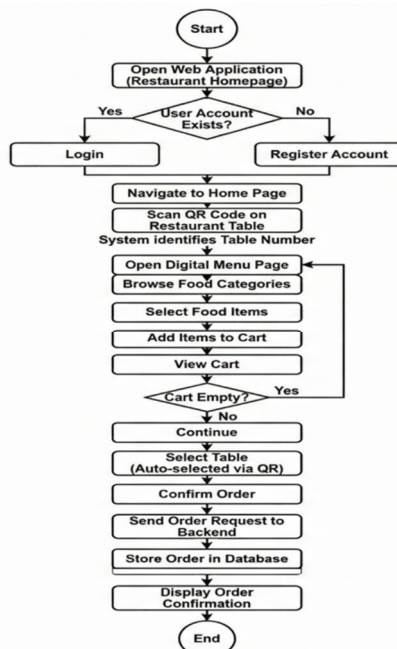


Fig.5. System flow chart illustrating the QR-based restaurant ordering process from menu access to order confirmation.

IV. EVALUATION AND RESULTS

The performance, usability, and dependability of the suggested QR code-based smart restaurant management system were assessed in a restaurant simulation. The assessment concentrated on database performance, order processing accuracy, and system responsiveness. Additionally, studies demonstrate that QR-based ordering platforms improve the ordering process for customers and lower operational complexity [12]. This evaluation's goal was to determine how well the system outperforms conventional restaurant ordering techniques in terms of service efficiency

A. User Interface Performance

The user interface's responsiveness and simplicity of use on various devices were assessed. After scanning the QR code on restaurant tables, patrons could instantly access the digital menu. The system worked flawlessly on desktop, tablet, and smartphone platforms because of its responsive design. During testing, there were no interface lags or navigational issues while registering or accessing the system (Fig.5).

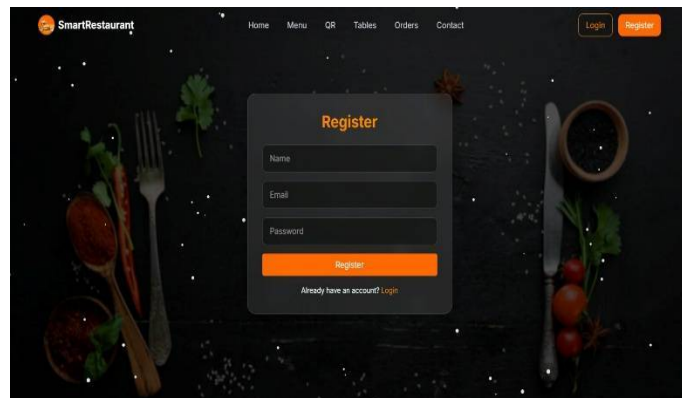


Fig. 5. User registration interface of the Smart Restaurant Management System.

The system worked flawlessly on desktop, tablet, and smartphone platforms because to its responsive design (Fig.6).

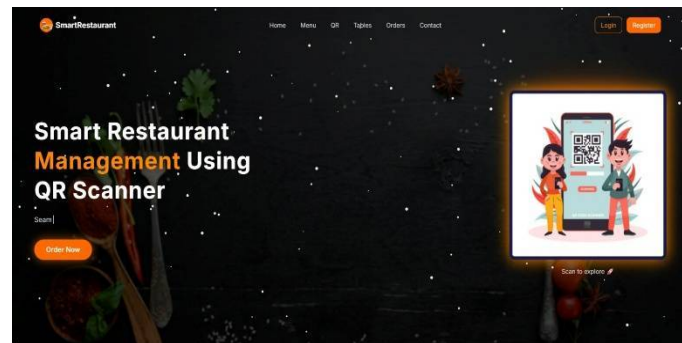


Fig.6. Homepage of the QR-based restaurant ordering platform.

The platform's primary functions, such as menu exploration and QR-based ordering, are easily accessible through the site. Its responsive design guarantees continuous performance and easy navigation on various devices. The main entry point for customers to engage with the restaurant ordering system is the homepage. It offers simple access to key areas including order monitoring, QR code access, and menu browsing.

B. Order Processing Efficiency

Several orders were placed concurrently from various devices to test the order processing module. By scanning the QR codes that were issued to each table, patrons could view the digital menu (Fig.7). The program successfully sent order data to the backend server via API requests once customers verified their orders. Without any data loss or processing mistakes, the backend handled these queries and saved the order information in the database. When managing concurrent requests, the system showed steady performance, suggesting that it can accommodate several patrons during peak restaurant hours.

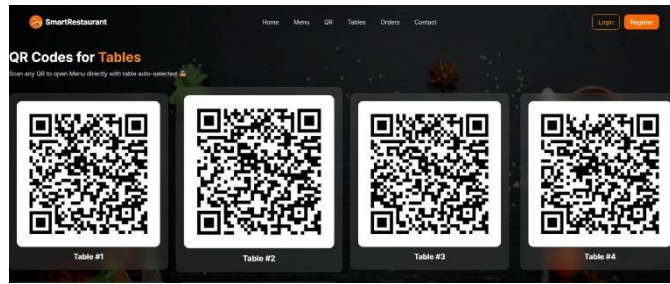


Fig.7. QR code interface for accessing the digital menu by table.

Using the digital menu interface, customers peruse menu items and add them to their cart (Fig. 8).



Fig.8. Digital menu interface displaying food items and ordering options.

C. Database Performance

To confirm the dependability of data storage and retrieval processes, the database layer was assessed. Restaurant data, including as menu items, client orders, and table information, was effectively managed by MongoDB. The database managed numerous read and write operations while keeping consistent data records during testing. Newly placed orders were instantly kept and accessible for restaurant employees to keep an eye on thanks to real-time updates.

The table selection and cart confirmation interface was used to confirm orders (Fig. 9). Before placing an order, clients can verify where they will be seated using the table selection screen. By ensuring that every order is accurately linked to the appropriate restaurant table, this step enhances order accuracy and service coordination.

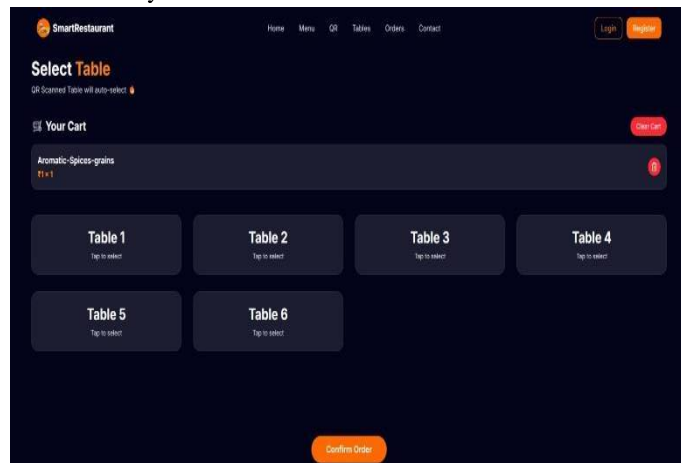


Fig.9. Table selection and cart confirmation interface for placing orders.

Additionally, the system has a contact interface that enables patrons to speak with restaurant management (Fig. 10).

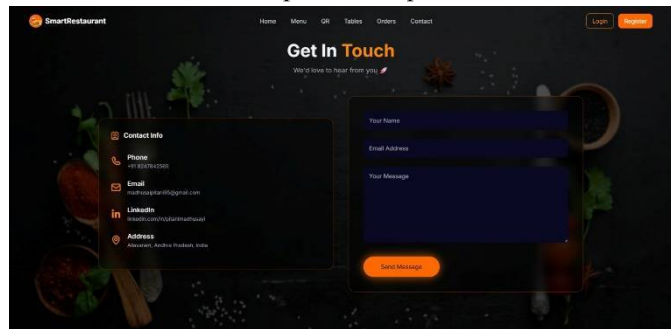


Fig.10. Contact page interface for customer communication with the restaurant.

The administrative dashboard allows restaurant employees to keep an eye on system data and order activity (Fig. 11).

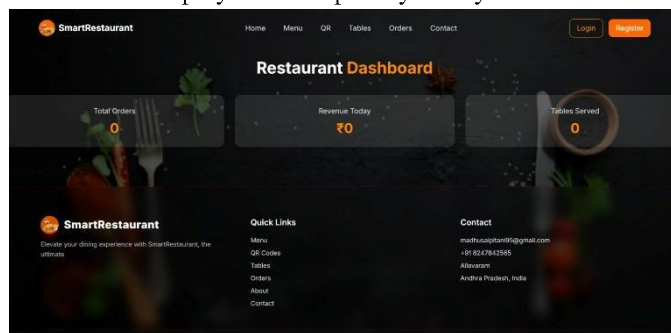


Fig.11. Restaurant admin dashboard displaying system statistics and information.

V. DISCUSSION

A. Design Validation and Key Observations

The suggested QR-based restaurant management system has a number of useful benefits when the actual architecture is evaluated. A responsive and scalable environment for managing numerous user interactions was made possible by the choice to construct the platform utilizing cutting-edge web technologies like Next.js for the frontend and Node.js for backend processing. The solution guarantees effective data storage and retrieval for menu items, customer orders, and table information by integrating a MongoDB database. The increase in service efficiency brought about by digital ordering was a significant finding during system testing. Furthermore, menu items, customer orders, and table information can be efficiently stored in centralized databases thanks to integrated restaurant management systems [13]. The suggested approach greatly lowers the possibility of order errors by enabling clients to place orders directly through their smartphones. By classifying menu items and enabling users to check their choices before finalizing orders, the digital menu interface further streamlines the browsing process.

Additionally, using QR codes to access menus reduces the requirement for printed menus, which lowers operational on a expenses and raising standards of hygiene. Restaurants can dynamically update menu items through the database thanks to the web-based architecture, guaranteeing that patrons always see the most recent menu information. Together, these design elements make the ordering procedure at restaurants more dependable and effective.

B. Limitations and Constraints

The suggested system has a number of benefits, but there are also some drawbacks. The availability of reliable internet connectivity in the restaurant setting is essential to the platform's operation. Customers may encounter delays when accessing the digital menu or placing orders if network connectivity is inadequate or non-existent. The method also presumes that users have cellphones that can access online apps and scan QR codes. Despite the ubiquitous use of smartphones, some consumers could still favor more conventional ordering techniques. Therefore, in order to serve every customer, restaurants might need to keep both digital and manual ordering methods. The platform's present scope is another drawback. The system's main functions are basic order management and consumer ordering.

The current solution lacks sophisticated functionality like integrated payment gateways, kitchen display systems, and real-time order analytics. Future iterations of the system may include these capabilities to increase its usefulness and offer a more complete restaurant management solution.

C. Alignment with Literature Findings

The suggested Smart Restaurant Management System's results closely match those of current studies on the restaurant industry's digital transition. According to a number of studies, traditional restaurant operations mostly rely on manual procedures, which frequently result in poor order handling, communication mistakes, and service delays. The suggested approach immediately solves these issues by allowing users to access menus and make orders using their cellphones via a digital ordering platform based on QR codes.

VI. CONCLUSION

For contemporary food service companies, increasing accuracy and efficiency in restaurant service continues to be a significant problem. The design and implementation of a smart restaurant management system utilizing QR codes, a web-based platform that lets patrons view digital menus and make orders straight from their cellphones, was described in this study. Customers can peruse menu items, add them to their basket, and confirm orders without assistance from restaurant workers by scanning QR codes that are posted on restaurant tables. As contactless restaurant service models lower physical interaction and raise hygienic standards, they have grown in popularity [14]. Effective data management and dependable service operation are ensured by integrating a backend order processing system with a dynamic web interface. The system greatly increases service speed and reduces communication errors by eliminating human order-taking procedures. Web-based restaurant automation systems offer dependable and scalable solutions for contemporary food service operations, according to recent studies [15]. To further improve restaurant management and customer experience, future development might incorporate online payment systems, kitchen display interfaces, and sophisticated analytics functions.

VII. ACKNOWLEDGMENT

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